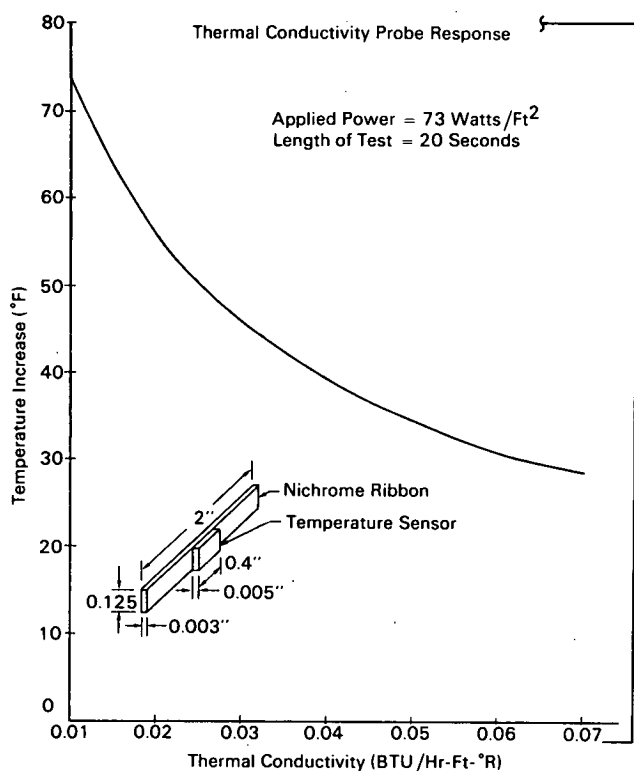


NASA TECH BRIEF



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Thermal Conductivity Probe



A low-mass probe was developed to measure the thermal conductivity of polyurethane foam while exposed to either hydrogen or helium permeation in a temperature range from ambient to cryogenic. The device consists of a nichrome heating element 0.003 in. thick and 0.125 in. wide combined with a bimetal temperature sensor (very accurate down to liquid-hydrogen temperatures) located at midpoint.

The need for a rapid means to determine the thermal conductivity of polyurethane foam with a mini-

mum of thermal disturbance led to the development of this probe. The two methods normally used were considered inadequate. However, one of these methods, the hot-wire type, was the basis for the development of the thermal conductivity probe in which a nichrome ribbon 2 by 0.125 by 0.003 in. was used. To this ribbon a temperature sensor 0.4 by 0.125 by 0.005 in. was bonded. The resulting probe was then embedded into a test specimen, energy of 73 W/ft² applied to the ends of the ribbon for 20 sec, and the increase in the temperature of the ribbon measured.

The probe was calibrated analytically for a 0.75 in. thick specimen with the following hot- and cold-face temperatures: (1) constant temperature of 80°F through the entire specimen; (2) linear temperature variation from 30°F cold-face temperature to 65°F hot-face temperature; and (3) linear temperature variation from -5°F cold-face temperature to 65°F hot-face temperature. All three initial conditions give the same temperature increase for a given thermal conductivity value as shown in the figure. With these results, the thermal conductivity of a specimen can be determined from an experimentally determined increase in temperature.

The probe is calibrated analytically at 73 W/ft². Because it is frequently difficult to maintain the experimental power setting at this exact value, a correction is necessary to convert the experimental temperature increase at a given power level to a temperature increase at 73 W/ft². It was determined experimentally that the probe can be treated as a semi-infinite solid for correcting small deviations. In a semi-infinite solid the surface temperature increase is proportional to the heating rate, allowing the following correction to be applied:

(continued overleaf)

$$\frac{\text{Experimental Temperature Increase}}{\text{Temperature Increase at 73 W/ft}^2} = \frac{\text{Applied Power}}{73}$$

Notes:

1. The thermal conductivity probe can be used to determine by nondestructive means the thermal characteristics of insulating materials.
2. This innovation may be of interest to the designers and manufacturers of refrigeration equipment and to the manufacturers of insulating materials.
3. No additional documentation is available. Specific questions, however, may be directed to:
Technology Utilization Officer
Marshall Space Flight Center
Huntsville, Alabama 35812
Reference: B69-10780

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: John Navickas of
McDonnell Douglas Corporation
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Marshall Space Flight Center
(MFS-20566)